Blind Luck

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Part I: General Overview of Business

•Pella Corporation has produced the finest quality windows and doors since 1925. Pella windows are found in homes all over the world. They focus on innovation and continuous improvement of their product. This focus requires a significant investment in research, design, and product testing.

Part II: Job Specifics

•Quality Assurance Lab: This lab tests all facets of the products made a Pella Corp. The QA lab ensures that current products meet industry standards and tests new product design feasibility.

•Solar wall test subjects windows to radiant heat produced by an array of light bulbs. This test simulates areas of intense sun exposure. (South facing window in extremely sunny climates.) Chamber temperatures are controlled to replicate high temps on outside and air conditioned climate on the inside.

Part III: Introduce the Problem

•Insynctive windows contain battery powered blinds that can be controlled via smartphone. The company is seeing a malfunction in the blinds causing them to reset (open/close and raise/lower) on their own. The malfunction seems to occur when the windows are exposed to direct sunlight. Preliminary tests show that after approximately an hour of direct sun exposure the voltage in the battery compartment (a series of 6 D-cell batteries) drops to zero. Around 5-10 minutes after cool down begins the voltage returns and the blinds begin the reset process. No damage to the batteries themselves has been detected.

- What do you think is causing the disconnection?
- At what temperature would you expect to see the voltage drop off?
- How would you test your prediction?
- Assuming your predicted cause is confirmed by your test how would you address the problem?

Part IV: Background

•Students will need to understand thermal expansion and how to calculate linear expansion of different materials at different temperatures. One possible solution involves understanding spring constants and Hooke's Law.

•The QA lab took a very scientific approach to solving this problem. A test was designed that exposed the blinds to simulated direct sunlight and recorded the voltage in the battery pack at the same time. This confirmed a voltage drop between at 120*F and 130*F; the point where the linear expansion of the battery case exceeds the linear expansion of the batteries themselves causing the batteries to lose contact. When the battery compartment cooled the batteries would regain the connection sending the blind's control mechanism into a reset sequence.

Part V: Business Solution

•The problem was solved by placing a stiffer retention spring in the battery case to keep the batteries in contact. (Although other solutions were discussed.) The cases with the new springs then successfully passed the same direct sunlight test the previous version had failed.

Part VI: Student Solutions

- I expect students to quickly identify thermal expansion as the culprit in malfunction. The possible solutions very widely. The simplest solutions involve loosening the battery case's grip on the battery so it does not pull the batteries apart or devising a more robust retention system to keep the batteries in place. (this is what was done) Some students will have more complicated solutions such as a repositioning of the battery pack or possibly using a different type of battery all together.